T962: Small TPC exposure to NuMI, on-axis Neutrino Beam

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6 June 2007 - FNAL Users' Meeting

http://t962.fnal.gov

Physics Goals

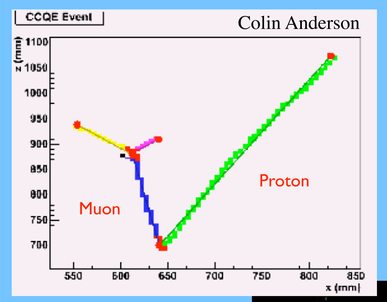
Seeing Events

- Main R&D goal for T962 is to see neutral current π^0 events
  - $\nu + p \longrightarrow \nu + p + \pi^0$
- Determine expected event rates by extrapolating data from PEANUT, an emulsion test beam in the future location of T962
- Expected event rates:
  - ~60,000 events total (given expected 6 month run in front of MINOS)
  - ~300 ν_μ events/day
  - ~600 ν_e events total

Long Term LArTPC Goals

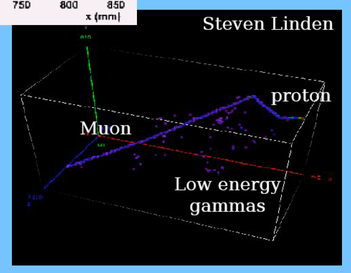
- Look for incidents of CP Violation
- Determine neutrino mass hierarchy
- Determine θ_{13}

Simulations



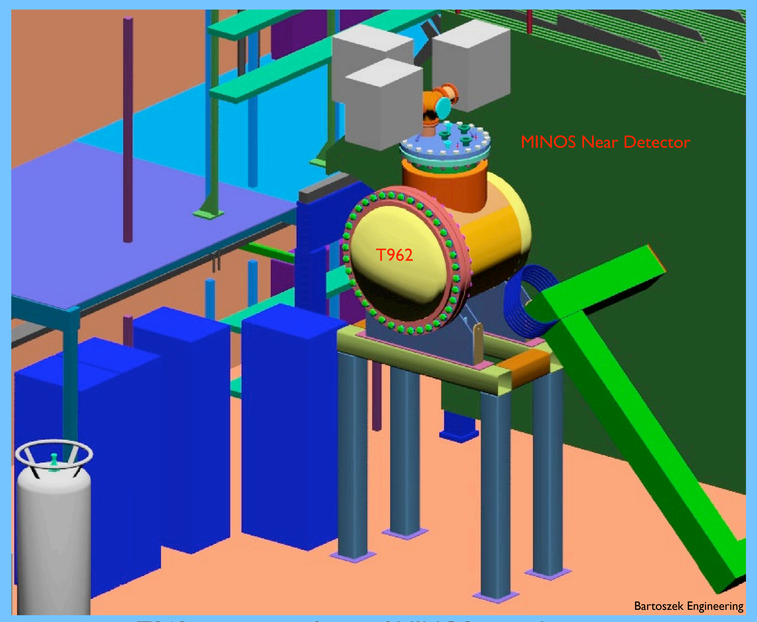
- Currently, there exists a Geant3 simulation of a LArTPC, built from the ICARUS Monte Carlo

- Eventual goal for T962 to create Geant4 simulation and automated reconstruction



Low energy interactions

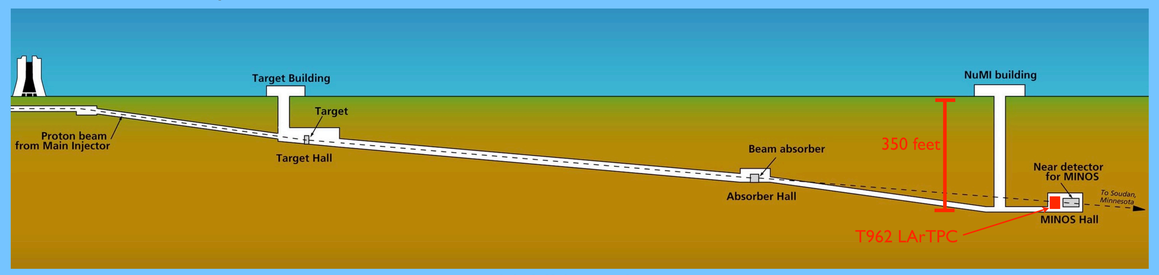
- First ever data on low energy neutrino interactions in a LArTPC
- T962 will measure in .1 to 10 GeV range; previous energy with 50 liter NOMAD LArTPC was 24 GeV



T962 cryostat in front of MINOS near detector

The NuMI beam and T962

- NuMI (Neutrinos at the Main Injector) beam passes through two MINOS detectors: a near detector at 1 km and a far detector at 735 km from target at Fermilab
- T962 LArTPC situated in front of near detector to detect low energy neutrinos from beam
- T962's data about low energy neutrino interactions necessary stepping stone to larger TPC
- TPC in T962 will have 480 channels of readout and ~5 mm pitch

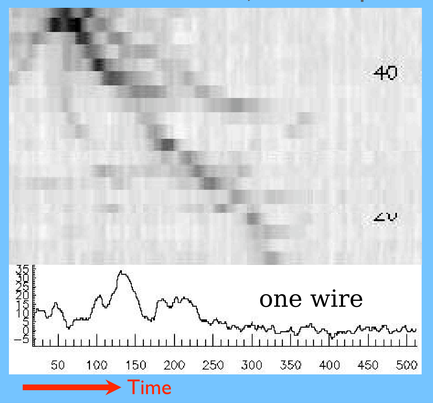


NuMI beam line

Functioning of Liquid Argon Time Projection Chambers (LArTPCs)

- Neutrinos travel through volume of liquid argon
- Some neutrinos interact with argon atom, releasing a proton or neutron
- Released particles ionize electrons and create ionization tracks
- Ionization particles are drifted through argon to collection and induction planes that take charge readings as function of time
- Wire readings used to reconstruct events with accurate, bubble chamber-like imaging

First ever tracks seen in US, at Yale in April 2007

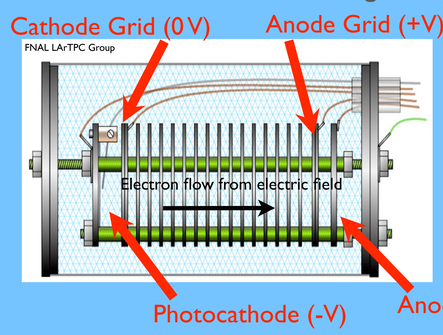


Technological Goals

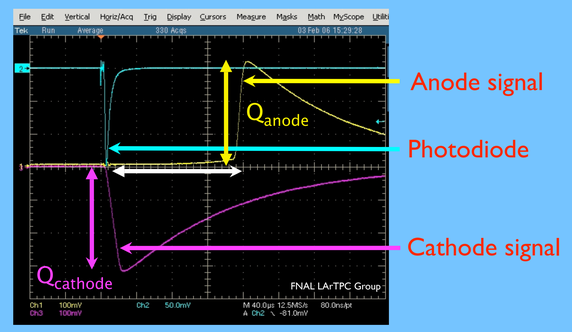
Argon purity

- High purity levels crucial to ensure undisturbed drifting of ionization particles
  - Polar molecules and ions bond with electrons from tracks making neutrino detecton impossible
  - Commercial argon impurity levels higher than required level of less than 1 part per billion
  - Additional impurities from LArTPC components and oxygen remaining in chamber before argon filling
- Filtration system passes argon through copper mesh, removing oxygen which forms copper oxide

Monitoring Purity



- Xenon flash lamp pulse releases electrons from photocathode
- Electrons drifted through argon and measured at anode
- Comparing electrons released to electrons collected at anode gives indication of argon purity



Experience in running underground system

- Will gain experience in running argon recirculation system, trigger system, and readout system with minimal above ground interference
- Acquire knowledge about conforming to safety standards, such as ODH requirements